

## NATURAL HAZARDS AND NATURAL RESOURCES OF THE BULGARIAN BLACK SEA COASTAL AREA

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**Abstract:** *The natural hazards are an important expression of the recent geodynamics of the coastal area. Natural resources provide sustainable society development. The interactions between them are important factors of the sustainability of the coastal area. The spatial distribution of both elements is under investigation. The advantages and disadvantages of the spatial locations show higher potential of the sea and on land social facilities since ancient times up to the present days.*

## ПРИРОДНИ БЕДСТВИЯ И ПРИРОДНИ РЕСУРСИ НА БЪЛГАРСКАТА КРАЙБРЕЖНА И МОРСКА ЗОНА

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**Ключови думи:** *Природни бедствия, природни ресурси, Черноморско крайбрежие на България*

**Резюме:** *Разгледани са най-широко разпространените природни бедствия и природни ресурси на Черноморското ни крайбрежие – както на сушата така и в акваторията на морето. Потърсени са взаимни връзки между тях. Оценени са възможностите местните природни ресурси да послужат за възстановяване и устойчиво развитие, в случай на природно бедствие, засегнало разглеждания регион.*

### Introduction

To study the influence of the natural hazards and their effects on the development of the coastal society is an important task investigated from different point of view especially to the sustainability and human safety and infrastructural security. On the other hand the natural resources define the societal progress and provide high standard of life. The coastal societies usually develop tourism and entertainment as priority all over the world. The Bulgarian Black Sea coastal area is not an exception. But in parallel a lot of other social activities help the progress and sustainability. For example the gas and oil production, the development of port facilities, the extensive fishery and seafood production as well as other heavy industry activities such as energy sector development ore and mineral exploration and exploitation, etc. are of vital importance for the balanced and effective social life. Without touching cultural and historical heritage the Bulgarian Black Sea coastal area both – on land and in the sea is threatened by different natural hazards which can destroy the sustainability for certain interval of time. The ability to recover is an important task of the administration and local people. The natural resources and reserves are the basement of the fast recovery and progress. A lot of international examples can prove this – The Kobe earthquake in 1995 and the earthquake and the tsunamis in 2011 in Japan, The earthquakes of the coast of Chile and Alaska and many others show the good practices for faster

recovery. On the other hand – the earthquake in Haiti, Indonesia (2004), Nepal (2015) and others show just the opposite examples, when the lack of reserves and resources slow the recovery process for a long time. Using the knowledge about all known data and information as well as some new technology solutions we try estimate all possible natural hazards and their destructive potential to the coastal society and on the other hand try to find all useful and potential resources which could be exploited in case of occurrence of hazardous events and their prevention and the possibility of sustainable development of the coastal society of Bulgaria.

### **The integration theory of the assessment of multihazard disasters which can affect the Bulgarian coastal area.**

This method is based on the historical analysis and recent knowledge about the disasters which can affect the Bulgarian coastal area. We are starting our investigation from North to South, following the conclusions of the Bulgarian Geological hazards map (scale 1:500 000) – Fig.1. The statistics is rather reliable and the conclusions look satisfactory.

#### **Natural hazards**

- Collapsibility of loess. The hazard spreads to the north part of the Black sea coast. It is mixed with some karsts activities. The negative influence could be expected to the buildings constructions, underground mining and collapse of the agricultural land. The level of the destructive potential is low, because simple geology and geophysical prospecting can define clearly the areas of potential threat.
- Rock falls and cracked deposits. The hazard is located to the rocks near to the sea and can be localized easy. Low destructive potential.
- Active faults and mud flows. These are surface geodynamic factors with low destructive potential.
- Active faults and earthquakes. The typical representative seismic source is so called Shabla-Kaliakra source. According to the maps of the seismic hazard this is one of the most dangerous seismic active sources. Typical example is the earthquake from 1901 – magnitude 7.1,  $I_{max}$  (intensity) X EMS. The location of the epicenter is in the sea about 10–15 km from the coast. The earthquake triggered big block subsidence (about 3 km<sup>2</sup>), large rock falls and landslides and even clear tsunami effects (about 3 meters local sea inundation in Balchik). The source has no clear origin. Some theories suspect the activation of the faults cross-section, another the fault's knot, but the observations did not confirm any of it. The source is characterized by very strong seismic events which occur irregularly, but there are a lot of historical descriptions about ancient strong earthquakes with very high magnitudes, strong destructive effects and triggering other destructive hazards like landslides, stone falls, tsunamis, etc. The destructive potential is very high and preventive, protective and safety measures are essential. The seismic source is one of the most active and hazardous all over the Black Sea coast
- Induced seismicity – some data about man-made earthquakes with magnitude up to 4.5 are observed due to the exploitation of the huge salt body near Devnia. The method of solution extraction is supposed to be a trigger of stress redistribution and small earthquakes generation. The subsidence is also observed.
- Tsunamis. As it was mentioned some local earthquakes can trigger tsunami. The far field tsunamis of seismic origin have been also observed – sources from Crimea, North Anatolian fault, Vrancea, etc. There are data about tsunamis generated by other phenomena – like underwater slides (turbidites), atmospheric disturbances as well as of not known origin. A typical representative event is this one from 7 May, 2007. It created local disturbances of the sea level with amplitude of about three meters. The models calculated on the basis of underwater landslide (because the seismic activity was not detected) as well as of atmospheric origin, does not confirm certainly the source of this tsunami generation mechanism. There are some hypotheses that large gas emissions and mud volcanoes can also trigger tsunamis. The model calculations for some typical cases show that the tsunami height can not go over 3 meters. But other calculations show very specific effect of some local peculiarities of the bottom and coastal geometry, which can focus the tsunami energy to some local places. This could be very dangerous and needs special investigations and modeling. For now the destructive potential is assessed as middle.
- Landslides. Almost the whole area of the Bulgarian northern Black Sea coast consists of large active landslides which are active due to the rainfalls, underground waters' levels

changes, triggered by earthquakes, etc. The destructive potential is very high and many roads, buildings and other facilities have been destructed during the historical times (Kavarna case - III c. BC) as well as recent constructions. To the south the Sarmatian lime stones (the main geological reason of the landslide process) are rarer and around Cape Emine the spreading of the active landslides is decreasing. The south part of the sea coast only rare cases can be observed.

- Erosion on land and on the costal rocks (abrasion) – widely spread all over the coast. Very clear expressed and could be avoided. Low destructive potential.
- Salt waters intrusion and silanization – widely spread and some salty lands are out of exploitation. Low destructive potential
- Floods. Flash floods are frequent event usually related to storms. The can affect the low lands and river estuaries and deltas. High destructive potential.
- Storms. The whole black Sea coast is vulnerable to storms. Surge storms and high sea water levels are frequently observed. Sometimes the sea level increased up to several meters. Wind storms are also frequent. High destructive potential due to the needs to close ports during the wind storms. Hail and snow storms are usual during the winter time. In general - high destructive potential.
- Icing. The northern part of the coast is frequently affected by icing during the winter times. Sometimes even the sea is freezing.
- Natural and artificial (due to the flotation ore processes) radioactivity. Observed on some beaches (for example “Vromos”) and waste deposits (for example near Rosen cooper mine).

#### **Natural resources (general view from North to South and from the land to the sea)**

The natural resources (mineral deposit, oil and gas, coal mining, etc.) are extracted from the general map of Bulgaria and show relative high concentration of different deposits in the coastal area – Fig. 2.

- The Shabla (Kamen briag-Tulenovo) oil deposit. Small block structured deposit which produces still very small quantities of heavy oil.
- Dobrudja coal basin. Deep (~3500 m) anthracite deposit with significant quantities, but due to the deep location and underground waters wait for innovative approach of exploitation.
- Manganese deposit. Huge deposit near Obrochishte. Mine exploitation. Potential for local people employment.
- Salt deposit near Devnya – base for chemical industry and potential of human employment.
- Gas seeps in the sea, related to the shallow depositions of methane. Predominantly located in the sea and near to the north coast. No industrial quantities are expected.
- The gas deposit Galata. Still produces gas. Some difficulties for the exploitation due to the high content of the abrasive material in the gas substrate.
- Healthy mud. High medically elective mud deposits near Balchik (Tuzlata) and Pomorie. High potential for health tourism.
- Hot mineral waters – wide spread to the north. Due to the Valangine water aquifer of lime stones. High potential for health tourism.
- Sapropel deposits due to the sea plants deposition. Considered as a resource with multiple application to the agriculture, pharmaceuticals, etc.
- Sea salt production – open exploitation and production near Bourgas and Pomorie.
- Black Sea coal basin north of Bourgas. Mining activity and exploitation.
- Cooper and multi metal ore deposits south of Bourgas (mines Rossen, Varli briag and Gramatikovo deposits). Ore exploitation since ancient times up to the present days.
- H<sub>2</sub>S – the sea water contains solution of H<sub>2</sub>S especially for the depths deeper then 150–200 m. There are expectations about industrial processing of this resource.
- Gas hydrates. Huge deposits in the sea around the coast. Considered as a huge source of energy. Expectations about industrial exploitation. Needs innovative approach
- The main and very large income factor is considered the tourism with all facilities and services. This is a very vulnerable sector of the natural hazards and strongly depends on the natural resources.



Fig. 1. Part of the Map of the geological hazard of the Bulgaria - Black Sea coast [2]



Fig. 2. Part of the Map of the natural resources on the coast. Only major deposits are presented [15]

## Conclusions

Regarding the natural hazards it is rather clear that a lot of disasters threaten the coastal area. Different in their physical properties and power, they are real danger for the population and infrastructure.

There is high probability of multihazards triggered by each other. For example the earthquakes can trigger tsunamis and on land and the bottom sea landslides (also rock falls and/or mudslides) and then landslides can trigger again tsunamis. The high winds water level changes can trigger floods, water salt intrusion and silanization.

There are observations about radioactive pollution due to the natural and anthropogenic factors. The gas and oil exploitation can triggered sea waters and coastal lands pollution.

Regarding the natural resources and reserves is clear that there is a large potential together with the tourism about industrial development (natural resources, port facilities, suitable places for communication and energy links, etc.)

Energy potential seems to be future development sector due to the wind energy, oil and gas interconnectors, expected deposits, H<sub>2</sub>S and gas hydrates exploitation, etc.

Industrial potential and trading industry are also with possibilities to increase and together with tourism can bring large benefits.

Both – natural hazards and natural resources are interconnected and prevention and safety measure are essential to preserve the human lives, industrial infrastructure and tourism. This approach can satisfy the requirements of sustainability and future development of the region.

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